

Test & Measurement World, December 2001

Power supply simulates battery

Charger test technique employs power-supply current-sinking capability.

By Jim McBride, LXE, Norcross, GA

With the increased use of battery-powered portable electronics, you might find yourself faced with testing the battery chargers that keep these products running. A battery charger is just an electronic circuit that provides charge to a battery. A charger typically sources a current to the battery and monitors the battery voltage to determine when the battery is fully charged. Often, a charger generates two or more current levels depending on the state of the battery. A charger may, for example, provide a bulk charge rate of C/5, which it maintains until the battery is fully charged, and a trickle charge rate of C/100, which it uses to maintain the battery at full charge (see "Battery charge rate,").

Types of battery chargers

Battery chargers range in complexity from a simple series resistor, to a transistor current source, to complex special-purpose battery-charger chips. The series resistor (**Figure 1**) is the simplest battery-charger circuit possible, yet it exhibits some intelligence lacking in more complex schemes—note that this simple circuit has feedback to reduce the charge current as the battery charges; as the battery voltage increases, the voltage drop across the resistor decreases, and the charge current is reduced, thereby inherently protecting the battery from being overcharged.

The transistor current source in **Figure 2** is more complicated. It employs a PNP transistor as a constant-current source to provide a constant charging current to the battery. In the circuit shown, a comparator monitors the battery voltage and reduces the charge current to a trickle-charge level when the battery has reached full charge. It accomplishes this by switching in a parallel resistor and changing the voltage-divider ratio.

Other much more complex battery charger circuits are based on special-purpose battery-charger chips. These chips may implement three or even four different charge levels and may include constant-voltage as well as constant-current charging modes. They also may perform other functions such as monitoring battery temperature.

Simulating batteries

Regardless of how the charger is implemented, it requires testing, and the test

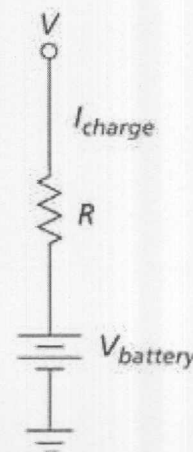


Figure 1. Although simple, a series resistor brings some intelligence to battery charging. The feedback effect of this circuit reduces charging current, I_{charge} , as battery voltage, V_{battery} , increases.

setup must include something to simulate the battery. You could use a real battery—and probably would for design verification—but use of real batteries is impractical for production testing. They are too slow to charge, and you'll have no way to control the charge level. Therefore, you'll require some type of battery simulator.

The simplest way to simulate a battery is with a resistor. This works fine in cases where the charger is a series resistor. The resistor that simulates the battery sinks the charge current, and you can measure the voltage drop across the resistor to calculate the charge current. This method also will work with a transistor current-source charger, but you may need more than one resistor to accommodate multiple charge levels. Also, it's difficult to measure the exact battery voltage at which the charger switches from one charge level to another.

Using resistors to simulate the battery will not usually work with charger chips, which require the battery to actually generate a voltage in the absence of charging current.

You also can use custom circuits to simulate batteries. These circuits will sink current and source voltage just like a real battery and thus, are very good for testing chargers. They may even include series resistance to simulate the internal resistance of the battery. The drawbacks are that they are difficult to design and may have to be altered to simulate particular battery types.

A very effective way to simulate a battery for testing chargers is to use a DC power supply that can sink current. You can easily find relatively expensive "4-quadrant" benchtop supplies that can source and sink current for either output voltage polarity. But one of the best kept secrets of DC power supplies is that some relatively low-cost unipolar models can sink as well as source current.

Figure 3 shows how to connect such a power supply to test a charger. In a typical automated test setup, you can use a power supply that provides current readback and that is controlled via an IEEE 488 interface. Set the power supply to the desired battery voltage, and then read back the current from the power supply. The current will be negative because the power supply is sinking it. If the charger has multiple charge levels, you can vary the power-supply voltage over the appropriate range to simulate the battery, all the while measuring and recording the various charge currents your DUT develops.

Choosing a DC power supply to simulate a battery

Exercise care when choosing a power supply to simulate a battery. Power supplies that are not designed to sink current could be damaged if used in this way. Always check with the manufacturer of the power supply before attempting to use it to sink current.

When choosing a power supply to sink current, you have basically two choices: special-purpose power supplies designed to source and sink current (such as the aforementioned 4-quadrant versions) and general-purpose power supplies that have current-sink capability. The special-purpose variety are typically high power and, thus, are not the best choice for testing most battery chargers. Generally, you'll want to use a general-purpose power supply, but

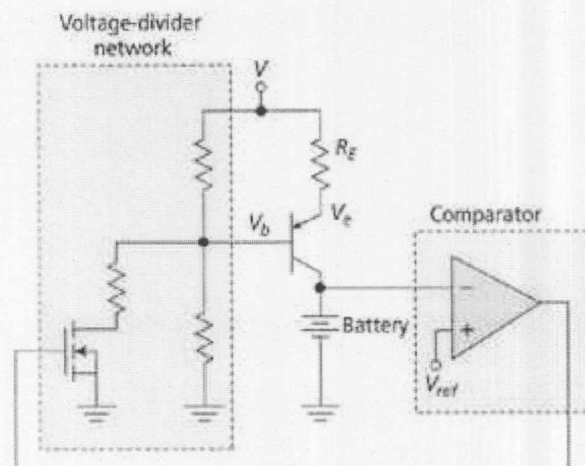


Figure 2. In this two-stage battery-charging circuit, a comparator determines when battery voltage equals target voltage, V_{ref} . The comparator then triggers a change in voltage-divider ratio to reduce charging current from a bulk to trickle level.

finding one that sinks current can be tricky, because this ability is not clearly spelled out in most power-supply specs.

When choosing a power supply to sink current, look for the down-programming specification. The ability of a power supply to quickly slew its output to a new voltage level is referred to as its up-programming and down-programming capability. The ability of the power supply to up-program, or increase its output voltage, is a function of its ability to source current and is specified under the worst-case full-load condition. The ability of the power supply to down-program, or reduce its output voltage, is specified under the worst-case no-load condition.

With no external load, the power supply must be able to discharge its output capacitors to reduce the output voltage. Often, an active down-programming circuit is added to decrease the fall time of the output voltage. It is this down-programming capability that allows the power supply to sink current from an external load—the battery charger in this case.

I've had luck using two different power supplies to test battery chargers. I installed an Agilent HP6624A quad-output IEEE 488 power supply in an automated test system. I've used it to test NiCd, NiMH, and Li Ion battery chargers with charge currents ranging from tens of mA to hundreds of mA.

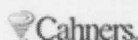
I've also used EMI/Lambda BOS-36-12 bipolar/operational/source-sink power supply to test a 7-A lead-acid battery charger. This is a special-purpose, 400-W, single-output, bipolar power supply that can source and sink current.

Using a DC power supply that can sink current is a simple and easy-to-implement solution for most battery charger test applications. It provides an accurate and comprehensive test that can be implemented quickly and inexpensively. **T&MW**

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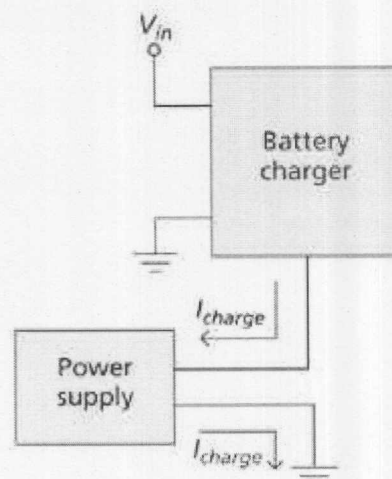


Figure 3. A power supply that can sink current can serve as a battery simulator. Such supplies are not typically advertised for the task, but you can check their "down-programming" specification for clues that they're suitable for this application.